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Modeling the Impact of Introduction of Influenza Vaccination on Influenza Cumulative Case Count in Cameroon

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0 Introduction

Influenza A virus is a major cause of acute respiratory disease in humans and is responsible for approximately 250,000 – 500,000 deaths annually worldwide. Pandemic influenza A virus infection resulted in significant morbidity and mortality in 1918 (H1N1), 1957 (H2N2), 1968 (H3N2), and 2009 (H1N1). The first outbreak of influenza A/H3N2 was reported in 1968 and has since affected multiple countries. Depending on the season, A(H3N2) strains are more prevalent than the other co-circulating viral sub-types with high morbidity and mortality rates.

Influenza vaccination is the most effective prevention measure to avoid influenza illness. However, Although influenza vaccination (utilization or access) is very limited in most of Africa, particularly Sub-Saharan Africa, there have been reported episodes involving viruses that have undergone drift due to antiviral and vaccine pressure from other regions.

Between 2009 - 2014, the US Department of Defense-GEIS implemented a surveillance project in Cameroon in order to better understand and identify the different strains of influenza circulating throughout the country. This project sought to understand the effectiveness of the virus as well and to identify any new emerging strains.

A total of 4,961 individuals who were enrolled in this study, 2,648 (53.37%) were female. The patients ranged in age from 2 months to 85 years old, with a mean age of 13.11 years old (SD= 15.68). 64.50 % of participants were under 15 years of age and 2.82% were older than 50 years.

Analysis showed that 4,052 (81.68%) samples were negative and 909 (18.32%) were positive. Among the positive samples, 442 (48.62%) were positive for Influenza type A, 460 were positive (50.60%) for Influenza type B, and 07 (0.77%) were positive for both Influenza types A & B.

1 Background

Influenza illness can range from mild to severe, and serious outcomes can occur in children and the elderly. Flu has been studied extensively in communities where flu vaccination rates are high. However, the burden of influenza is not well known in tropical regions where vaccine coverage is low. Our study examines the impact of influenza vaccination introduction on cumulative incidence in a Cameroonian population with less than 0.2% influenza vaccine utilization.

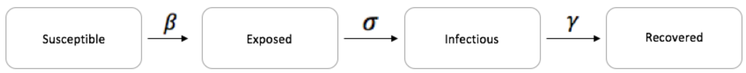
2 Objective

- The objective of our study was to estimate the impact of introduction of influenza vaccination on influenza cumulative case count in Cameroon.

3 Methodology

- The data for the analysis consisted of one year of influenza surveillance among patients presenting with influenza-like-illness at clinics in Cameroon.
- Samples underwent RT-PCR influenza screening
- Analysis were performed in Berkeley Madonna software.
- We developed Ordinary Differential Equations (ODE)s under the SEIR compartmental model and calculated R_0
- We estimated the proportion of cases the clinics observed to make inferences to the catchment population of these health facilities
- We developed another set of ODEs to introduce vaccination using a pulse function with a 50% vaccine efficacy under two scenarios: 45% and 10% vaccination coverage.

4 Mathematical Model



Parameters:

λ(t) = β(I/N) = force of infection
β = rate at which two specific individuals come into effective contact per unit time
f = rate of progression from latent to infectious
r = recovery rate

Incidence = f*E*rho

tv = 25, timing of vaccination
vaccP = 0.45, proportion vaccinated
eff= 0.5, vaccine effectiveness

Equations (without vaccination):

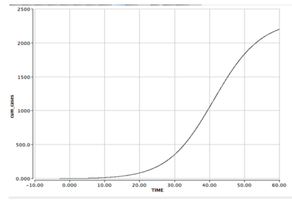
dS/dt = -β(I/N)S
dE/dt = -β(I/N)S - *f*(E)
dI/dt = *f*(E) – r(I) dR/dt = r(I)

Equations (vaccination):

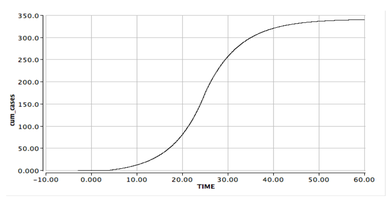
d/dt(S) = -β(I/N)S - pulse(Inf0,t0,1000) - pulse(S(vaccP*eff), tv, 1000) d/dt(E) = β(I/N)S - f*E + pulse(Inf0,t0,1000)
d/dt(I) = f*E - rec*I
d/dt(R) = rec*I + pulse(S*vaccP*eff, tv, 1000)

5 Results

By introducing influenza vaccination at 45% coverage (the U.S. average), the study observed a 82.9% reduction in influenza cases (1988 to 338). Cameroon would likely achieve reduced coverage (given accessibility of influenza vaccine). Therefore, we examined introducing vaccination with 10% coverage, and observed that flu cases were cut by over one third.



Cumulative cases expected among catchment population without vaccination.



Cumulative cases expected among catchment population of Cameroonian clinics with 45% vaccination coverage.

6 Conclusion

This analysis demonstrates that introducing vaccination in Cameroon clinics would reduce influenza cases substantially, even if only a small proportion of the population is vaccinated. Flu vaccination campaigns should be strongly considered as they can have potential to reduce case count which, in turn, can reduce the likelihood of transmitting flu to those who are most vulnerable to severe outcomes.

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